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SUSTAINABILITY OF ARCHITECTONIC CONSERVATION YARDS IN ENVIRONMENTAL PROTECTED AREAS: THE CASE OF THE ZÉNOBITO TOWER IN CAPRAIA ISLAND

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Abstract

The issues addressed in the restoration project for Zénobito's Tower, in Capraia Island, are a stimulus for a broader debate on sustainability of architectural preservation interventions in delicate environmental contexts inside protected areas. As a matter of fact the preservation intervention on the tower and the absolute preservation of the environmental context impose a severity rarely practiced, even in restoration. The tower is three and half hours walking distance from the village, in a wilderness area where in some periods even walking is forbidden, due to protection of nesting birds. The sea in front of it is a marine protected reserve, with severe limits on access by boat. The authors set the goals of the projects for restoration of this heritage as material conservation of the tower; minimal intervention; reversibility or retractability; usage of eco-friendly materials. All this led to a serious reflection and a careful evaluation of every factor that may have an impact on the environment. This paper includes a theoretical discussion, puts several questions and suggests guidelines that should be valid in all similar situations.

Keywords: *Cultural and natural heritage; Restoration; Material for preservation interventions; Minimal intervention; Protected areas; Eco-friendly materials.*

Introduction

The issues addressed in this study about the possible restoration of Zénobito Tower in Capraia Island, are the opportunity for a broader debate that involves the problem of the sustainability of interventions of architectural conservation in extremely sensitive protected environmental contexts. In this case the two (seemingly) opposing requirements, the intervention and the absolute preservation of the environmental context impose a severity in operations rarely practiced in the yards, even for restoration.

The tower is located is an unspoiled natural area, three and a half hours walking distance from village, with no roads (Fig. 1). In some periods of the year even the simple passage of people on the footpath is forbidden to protect the nesting birds. The sea under the tower is a marine reserve, with strict limits to vessels transit. The tower is now abandoned, conservation

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conditions are fair, some decay process are present, local authorities expressed the wish for restoration and development, economic resources for this are not available yet.

Fig. 1. The southern tip of Capraia Island with the Zénobito tower

The authors are proposing a set of goals for this restoration project: an absolute material conservation of the tower with minimal intervention, limited to safety issues of the elements that are in danger of collapse, reversibility or retractability combined with the use of eco-friendly materials. This situation led to a serious reflection and a careful evaluation of all the factors that may have an impact on the environment when preparing a restoration yard in a location with such high environmental and landscape value. The different restoration steps were examined in details: the preparation, installation and operation of the construction yard (including transport and disassembly issues), the post-construction monitoring and maintenance phases. The economic sustainability issue is very important in this case, it cannot be bypassed, and it is closely related to other aspects mentioned above.

The study also took into account the potential users of the area and we tried to put in place specific strategies for their involvement in the post-construction with continuous monitoring.

This paper, starting from this real case, proposes a theoretical reflection pointing out to lines of intervention valid in all restoration cases beyond this single (D.P. and F.F.).

The site and its history

Zénobito is the name of the southern cape of the Capraia Island, in front of Tuscany, topped by a watch-over tower that has the same name and shows all the signs of time, having more than four centuries of history. This tower was built for defensive purposes to identify pirate vessels heading towards Capraia or Corsica. Its construction was strongly supported by the Banco di San Giorgio because the island, belonging to the Republic of Genoa and strategic point on the route Corsica-Genoa, was sacked in 1540 by pirates headed by Dragut. The project included the fortification of the island with the renovation and expansion of the fortress built by the Pisans in XIIth century and the construction of two towers: the harbour tower, on northern side of the island, to defend the harbour bay and prevent landing of enemy ships, and the Zénobito tower. The two towers had the same shape, but the last had a larger diameter.

The decision to build Zénobito Tower was taken in 1544, but work did not begin until the following year and it was completed in December 1545. The achievement was particularly difficult because the cape was in a difficult position to reach: with the exception of stones

blocks that were extracted nearby, all other construction materials (lime and sand for mortar, beams for floors and for carpentry) had to be transported by sea from the port of Capraia, 5 miles away from the site in question, and then carried on the back of mules along a steep slope. Water was collected from small local sources not easily accessible. The workforce were mainly Capraia women, who daily walked both way from the main village 5 miles away (F.F.)

Construction materials

Sources of construction materials were manifold. The rafters were made with Mediterranean trees that covered the island, mainly oaks, now almost disappeared. The stone blocks for the masonry, as previously mentioned, were extracted locally and are constituted by trachybasalt-shoshonitic volcanic rocks [1]. Capraia is a volcanic island, therefore it has no carbonate rocks, which are essential for the production of lime. R. Moresco [2] reports that lime used in the island of Capraia came from Genoa and Corsica. Same author writes that the sand for the aggregate was collected from the beach of the port. Archaeometric investigations evidenced that the mortar of the tower (bedding mortars and mortar wall coating for plastering) has been realized with an aggregate constituted mainly by sub-angular fragments of andesitic-riodacitic volcanic rocks and a binder of magnesium lime, a type of lime traditionally produced in Liguria since twelfth century [3]; main production areas were in Genoa area, the dolomite of Monte Gazzo and Cogoleto, and in Savona area near Vado Ligure; in Corsica this type of lime could not be produced because of lack of dolomite rocks. These facts allows us to understand the great historical interest for materials used to build the tower, the importance of the preservation of its material consistency and also the complexity of the restoration in order to maintain the image acquired by the artefact (F.F.).

Site description and conservation conditions

The tower consists of a base conical plastered body, with a cylindrical body standing over it that had a gallery all around (we can now recognize the corbels that supported it). Inside there are multiple levels, the main room is dominated by an elegant fireplace where is a mezzanine. The entrance door is at half height of the tower for a better defence.

Currently the tower, which has no static problems, shows important remains of the plaster coating, still characterized by good adhesion to the wall (Fig. 2).

Fig. 2. The shape of the tower with the plastered conical base and the overlying cylindrical body with the corbels that supported a gallery

This was achieved in a structure based on two walls, an outer and an inner one, linked by a core element. The outer wall is composed of blocks of volcanic rock, roughly shaped and put in place with a rich mortar, made necessary by the irregularities of the same blocks (Fig. 3).

This masonry still shows good cohesion, even if the mortar joints are deeply eroded. Only on the southeast face, a well-defined portion of the external wall fell, uncovering the wall core structure (Fig. 4). Therefore the major preservation problems are in this area and in the upper part of the cylindrical body where the corbels that supported the gallery (no longer present) are deeply eroded and in some cases missing at all. These areas definitely need a restoration that allows stopping the progress of decay mainly due to marine-salts crystallization with the consequent fall of stone elements, but this must be a localized, "non-invasive" minimal intervention. In this regard, from great nineteenth century masters of restoration to recent claims of some contemporary restoration theorists, a common line of thought states that an area that displays and maintains the *patina* of time proves to be a very interesting element, worthy of being kept and maintained [4-11]. Moreover, when an architectural surface is in a state of "quasi-equilibrium", i.e. then the degradation progress is negligible, the non-intervention is preferable [12, 13]. All these concepts have been considered in this project (F.F.).

Fig. 3. The masonry made of volcanic rock blocks roughly shaped and put in place with an abundant mortar, made necessary by the irregularities of the same blocks

Fig. 4. In the conical base, left side of the image, remains of the covering plaster still with good adhesion of the masonry, are visible; on the right side it is evident the zone where a portion of the external wall fell, uncovering the wall core structure. With red asterisks are marked the stone blocks that in 2010 where still on site and that in the 2013 survey fell down.

Project goals and action lines

For the correct execution of each intervention of restoration/conservation it is fundamental to understand the phenomena that had led to the present condition. The proper understanding of these phenomena makes it possible to choose the most suitable operative technologies (methods, products) in order to ensure a chemical, physical and mechanical compatibility with the artefact without generating damages in the short and long-term. As a matter of fact such damages so frequently have been observed in past restorations. For this purpose a proper diagnostic campaign must be foreseen that takes into consideration various aspects such as the constitutive materials, the past interventions, the structural problems, the conditions of exposure, the climate, the history of the artefacts

Material for preservation

The reasons to preserve the material elements of heritage come from the awareness, gained in recent years, of the vast wealth of knowledge contained in it [14].

The project will therefore provide for specific preservative attention in construction activities with a final check on size and nature of changes introduced, on the distance from the initial condition [15].

Minimum intervention

Minimum physical intervention, means making the minimum change to an historic building or place [16]. This principle is possible due to the actions listed below:

The *public access conditions* should be unchanged, i.e. the visit should not be permitted inside the tower when the restoration will be completed. A “public access” solution would be very expensive and most important also it would have too much impact on the tower and on the whole skyline. This was a watchtower, a defense building, the unique entrance is located at a height of 3 meters on the wall. Allowing public access inside the tower would mean having an external staircase or a ramp on the south, with partial disfigurement of the image of the tower.

The proposed alternative solution is making a *virtual tour inside the tower* with the production of a video that will be shown in a permanent exhibition in the other tower at the north end of the island; this second tower has been recently restored, is open to the public and is suitable for this purpose. This solution, among other things, would have the advantage of linking the two towers. Besides the permanent exhibition it may contain display panels on the history of the construction of the two towers, their materials and construction details. It could also be an opportunity to show the different phases of the restoration yard of the tower of Zénobito.

Another reason to avoid public access is that it would require an expensive guardianship on-site and it is unlikely to find economic resources for this.

To weed or not to weed? The question is either lichens or mosses over tower and base rock surfaces should be kept or removed. The action line proposed by the design team for this case is “non-intervention but monitoring”. The debate only regards small vegetation that covers building surface; if tall trees were found planted in the walls, they would certainly be eliminated, cut and poisoned, because of the threat they pose on structures; however preliminary survey didn’t identify such situations. Scientific literature shows recent contributions both in favour and against weeding, they pose conflicting issues, and there is not a general solution. Lichens and mosses lived together with the tower for centuries, in a natural environment. A weeding operation would be complex because of the ecological constraints, and it should be periodically repeated to keep its effectiveness, originating new costs. The proposal of the design team is that, in the preliminary phase of the construction yard, a study should be made on the interaction lichen-stone and lichen-mortar. A weeding intervention should be avoided, unless the preliminary study finds important decay traces. This study would also be a

pilot study on this problem that concerns several heritages along national and international coasts.

Another debate issue is *whether to reconstruct the masonry or not*. The conspicuous lack of material in the south-east masonry, which has been mentioned above, should be carefully analysed in the phase that anticipates the construction yard itself. Today, as a matter of fact, it is not yet clear whether it is simply deterioration or it comes from human activity, for example a cannon shot. This must be understood.

In case of artificial origin the lack should be described in stratigraphic analysis, but it should not be filled again, because the lack itself is an historical document; intervention should be restricted to safety issues, i.e. avoiding falls of materials and injuries to people below.

There is a major benefit of leaving the current state: current lack of coverage let us see the three masonry layers inside, two external well-finished stone blocks walls with a filling layer in between, bearing information in great extent. As Doglioni says, "*often traces of construction stratification are 'naturally' brought back to light by the effects of irregular degradation of surfaces; in these cases the effects of degradation and the traces of stratification cannot be divided, they permeate each other as a stratigraphic evidence; in these cases, if I want to keep stratigraphic traces ant their readability, I cannot delete completely decay effects, I must take care of decay roots and stop decay progress, while keeping decay effects, minimizing them in case"* [15].

The main reason in favour of a reconstruction of the missed masonry is the risk of further decay of the structure in absence of such a reconstruction. In case the current state has not an artificial origin, but it is the result of a natural decay, all these pros and cons of an intervention should be evaluated, after an initial study that investigates why the lack has such a narrow extension, the relation to changes in materials or microclimate, for example wind prevailing direction.

If the intervention will be decided, this would be easy to read and distinguish from original parts. New mortar, for example, should distinguish itself from original one; this would be easily obtained because in Italy it is illegal to use marine sand to make mortar, as they did in these times. The hidden masonry wall inside should be photographed before being hidden again, and photos should be exhibited in a museum, for example in the second tower near the village.

The plaster over the masonry is missing in large parts of the tower, the action line is to keep it unmodified, because the masonry under it seems to be at "quasi-equilibrium".

Reversibility or retractability

The design team wants the intervention to be reversible, i.e. the change could be removed. This is most important for materials that are added to the building. Suppose that a metal beam is used in the restoration. In case in some future a better product will be available, the old beam should be removed and substituted with the new one.

In this situation the different reversibility concept is also applied to the environment around the tower. At the end of the restoration yard the environment should go back to its initial state.

Retractability is a different concept, i.e. the possibility to treat again the artefact after restoration. For example if a paint is used in restoration, retractability means that a new layer of a different paint may be added in a second time, if needed [17].

Ecologic materials

Material and substances selected for application should strictly be examined, evaluating ecologic and environmental issues along the whole lifecycle, from manufacturing to disposal. New REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) and CLP (Classification, Labelling and Packaging) European regulations will be an important guideline

in this. For the mortar, a magnesium lime with a composition similar to the original one will be selected, or a natural hydraulic lime. (D.P.)

A complex restoration yard

Because of the environment in which the tower is located, the site also has a number of critical issues that require careful examination. The preliminary study phase is already active. The accessibility for the installation of the construction yard, the subsequent operation and final rollback needs attention and a careful design. Also it is important to think in advance about what will happen after the intervention completion. This Capraia experience could be a model for interventions in similar contexts.

Here is a list of the main practical problems already identified.

Construction yard installation

We are in an area of a natural park both in the terrestrial environment (notice that there are many endemic plant species) and in the marine environment. So a thorough plan must be done for the installation of the construction yard, for construction materials transport (by land?, by sea? by air? see notes below), and for the dismantling of the construction yard at the end.

The problems which need to be taken into account at this stage are: 1) Scaffolding 2) Access 3) Materials and techniques 4) Timeframe.

1) Scaffolding. Materials will be up to standard, to ensure maximum protection (about it some careful thought should be done about the possibility of protection during work on site by the intense marine aerosol which has especially in conjunction with storm surges). However, at the same time, these materials must provide the least possible environment impact. Birds usually nest in the area adjacent to the tower itself: the yard must not disturb these birds neither change their habits. When construction yard will be over, and all the materials have been removed from the scaffolding, nothing must be left on the territory, no trace. For example no hole should be dig in the rock. Even in the case of support for materials and equipment, the situation of the grass and vegetation should not be modified or otherwise, after construction end, it should go back to the pre-construction conditions in the shortest possible time.
2) Access. There are two possible ways to access the construction yard: by sea and by sky. The land route is excluded, because there are only few footpaths, unsuitable even for small tracked vehicles, and the walk distance from Capraia main village is too large

2a) access by sea. It seems the most easy one. Keep in mind, however, that we are in a park area. The ship type (tonnage, eco-compatibility, speed) must be suitably selected. Trips frequency could be subject to regulations. A smaller number of trip schedule would be better, but in this case a larger ship and a larger storage area are needed. Large storage areas are not very common in the neighbourhood, and they pose new problems.

Materials disembarkation and final delivery to the tower site. The footpaths from the bay to the tower must not be changed at all. A different solution should be found, such as an environmentally safe cableway. Ground anchoring elements must be completely removed at the end of work. An anchorage inside the sea could be an alternative option for the lower end, but in this case the anchor solution should be carefully designed, a reinforced concrete should be discarded, a suitably shaped rock block should be preferred, with the aim of preservation of underwater plant lives.

2b) access by air, via helicopter. In this case an appropriate landing area must be realized in the plane near the tower (less than 100 m away from the tower), without altering the shrubbery. However even the movement from the plane to the tower is not easy. As a consequence also in this case another additional solution would be necessary, for

example a little cableway. And the helicopter could pose problems with birds. For this reasons the access by air seems less suitable.

3) Materials and construction techniques. For the reasons explained above, easily transportable materials should be preferred, for the same quality. Also there is a preference for techniques that require light equipment.
4) Timeframe. In addition to usual considerations on the most suitable seasons to perform specific processing, in this case new issues must be addressed: sea conditions (storm frequency and average intensity, in case the sea transportation option is choose), tourist period (this aspect must be arranged with the competent authorities), bird nesting season issues.

Construction yard operation phase

This phase put requirements on the activities, techniques and equipment, with a preference on solution less noisy, bulky or otherwise polluting. It is also important to minimize the materials transport burden, both for economic reasons but also for environmental reasons, in order to disturb as little as possible to the terrestrial and marine fauna. Another issue is water and electricity supply, a solution must be identify for this. Another goal to keep in mind will be to prioritize, always with the same performance and efficiency, environmentally friendly materials. This would be a pilot site on these issues.

Dismantling of the yard

The problems relating to the material handling will be similar to those already described for the installation of the construction yard. At this stage particular care should be paid not to leave traces of the yard coming back (in surrounding area of the tower) to a situation similar to the one found before the construction yard. (D.P.)

Economic issues

In these cases, as described above, the difficult task to put together the conflicting demands of a safe, effective, efficient, environmentally friendly and low cost construction yard becomes even more difficult for the constraint of a minimal intervention on the tower itself. A special attention is needed to avoid unneeded or incoherent extensions to the original work scope, as it often happens when the yard is in place: the minimal intervention line must stick to the original minimal set of changes.

This is certainly an emblematic, very special case, because of the environmental conditions of the object to be restored. However we think that these very specific circumstances can help us to ask ourselves good questions that otherwise would not be raised. In most cases this decision is placed in opposition to a possible economic saving. Hence another variable intervenes: that of economic sustainability. In our opinion, it is fair to hold together the various sides of the problem, but when thinking about the solution we need to think in a new way.

Post-construction monitoring and maintenance phase

The first step of sustainability is maintenance, which is linked to survey and monitoring: in order to implement these two actions the users themselves must be involved. A possible solution is a mechanism where the users themselves collect data on-site, like georeferenced photographs, videos, messages, sending them to a central monitoring repository, covering not only the tower but also the footpaths, the coast, the animals. This could be a valuable support for a post intervention conservation effort, that should not rely completely on end-users contributes, but it may be helped and made more efficient by it, a kind of assisted diagnosis. Nowadays technologies make this kind of solutions affordable. (D.P.)

Conclusions

What motivations can be offered to those who support the need for a limited restoration action, respectful of building material consistency and of the environment?

At this point it is necessary to refer to the concepts of cultural identity and a new conservation concept. As Stefano Della Torre said "*The difficult construction of tools for integrated and sustainable conservation of cultural values is an exciting challenge, but it still needs much work even theoretically. A big issue is identity: the frequent assertion that cultural heritage found in old buildings constitute our 'identity' should be re-evaluated in a time where everyone lives multiple memberships, less and less tied to territorial definitions...* " [18].

Beyond this specific case, the reflection presented in this paper concerns the reality of many similar situations, with an extreme vulnerability of architectural and environmental assets associated to limited economic resources of small local institutions.

First of all we need to understand (since the design phase) all the possible interactions artefact-environment, yard-environment, artefact-user. Overall sustainability indicators should be studied and prepared, including the post-intervention phase. Indicators of environmental sustainability, i.e. data and parameters for qualitative and quantitative assessment of the environmental and socio-economic issues, have already been discussed since the sixties and since those years the complexity of the interconnections is manifest. A new serious reflection on these issues is necessary focusing on restoration / preservation problems along the three phases before, during and after the restoration yard, including post-intervention monitoring, control and managing phase and relationship with the environment of artefacts located in delicate environments.

At the same time a distinct possibility for synergies with other local authorities and research institutes should be accessible to local authorities in order to abe able to act in a sustainable way (D.P.).

References

[1] L. Chelazzi, L. Bindi, F. Olmi, S. Menchetti, A. Peccerillo, S. Conticelli, A lamproitic component in the high-K calc-alkaline volcanic rocks of the Capraia Island, Tuscan magmatic province: evidence from clinopyroxene crystal chemical data, **Periodico di Mineralogia**., **75**(2-3), 2006, pp. 75-94.

[2] R. Moresco, Capraia sotto il governo delle Compere di San Giorgio (1506-1562). **Atti della Società Ligure di Storia Patria,** Genova, Italy, **47**(1), 2007, pp. 357-428.

[3] F. Fratini, E. Pecchioni, E. Pandeli, M. Camaiti, L. Amadei, *Le malte della Torre dello Zenòbito all'isola di Capraia: come murare in un' isola vulcanica?*, **Proceeding of the VIIth Archaeometry National Congress AIAR**, 22th-24th February 2012, Modena, Italy, pp. 753-762.

[4] C. Brandi, **Teoria del restauro**, Edizioni di Storia e Letteratura, Roma, 1963.

[5] F. Doglioni, **Stratigrafie e Restauro. Tra conoscenza e conservazione dell'architettura**, LINT, Trieste, 1997.

[6] F. Doglioni, **Nel restauro. Progetti per le architetture del passato**, Marsilio, Venezia, 2008.

[7] M.R. Escorteganha, J. Bayon, A.G. Santiago, F.A. Richter, T.G. Costa, *Interdisciplinary Studies of the "Vista Do Desterro" Painting: Historical Approach, Analysis of Materials and Preservation/Restoration Techniques,* **International Journal of Conservation Science, 6(**3), 2015, pp 273-286.

[8] M. Sorriso-Valvo, *Natural Hazards And Natural Heritage - Common Origins and Interference With Cultural Heritage,* **Geografia Fisica e Dinamica Quaternaria, 31**(2), 2008, pp 231-237.

[9] C. Bionaz, *Preservation and energy behaviour in Aosta Valley's traditional buildings*, **Vernacular Architecture: Towards a Sustainable Future** , 2015, pp. 129-134.
[10] Causevic, L. Kudumovic, N. Rustempasic, N. Kuljuh, *Sustainable Rehabilitation, Preservation and Protection of Access Arch Stone Bridge at the Entrance to the Medieval Old Town Korcula*, **Structural Analysis of Historical Constructions, Vols 1-3, 2012, pp.** 2132-2138.
[11] A.A. Costa, A. Arede, A. Costa, C.S. Oliveira, *In situ cyclic tests on existing stone masonry walls and strengthening solutions*, **Earthquake Engineering and Structural Dynamics, 40**(4), 2011, pp. 449-471.
[12] I Arce, F. Doglioni, R. Parenti, *Gli strati di rivestimento: strategie e tecniche di indagine tra conoscenza dello spessore storico e finalità di conservazione/restauro*, **Proceedings of the XIIth International Congress "Scienza e Beni Culturali: Dal sito archeologico all'archeologia del costruito. Conoscenza, progetto e conservazione**, 3rd-6th July 1996, Brixen (Italy), pp. 39-48.
[13] D. Pittaluga, F. Fratini, *Gli strumenti per affermare che una superficie è nello stato di "quasi-equilibrio" sono sufficienti?*, **Proceedings of the XXVIIIth Congress Scienza e Beni Culturali: la conservazione del patrimonio architettonico all'aperto**, 10th-13th July 2012 Brixen (Italy), pp. 23-32.
[14] D. Pittaluga, **Questioni di archeologia dell'architettura e restauro**, ECIG, Genova, 2009.
[15] F. Doglioni, *Ruolo e salvaguardia delle evidenze stratigrafiche nel progetto e nel cantiere di restauro*, **Arqueologia y salvaguardia, 1**, 2002, pp. 113-130.
[16] S. Della Torre, V. Pracchi, **Il restauro tra evento e processo: sfumature di significato nel concetto di minimo intervento in "Il minimo intervento nel restauro**, Nardini, Firenze, 2004.
[17] A. Bellini, *Restauro, conservazione e reversibilità in architettura. Brevi note*, **La reversibilità nel restauro. Riflessioni, esperienze, percorsi di ricerca**, (Biscontin G., Driussi G. editors), Arcadia Ricerche, Venezia, 2003, pp.1-4.
[18] S. Della Torre, *Programmare la conservazione: valore culturale e sostenibilità*, **La fruizione sostenibile del bene culturale**, Nardini, Firenze, 2006, pp. 24-27.

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